

## Study of Naturally Occurring Antimony Isotopes

Jyrki Pienmunne<sup>1</sup>, Simon Jackson<sup>1</sup>, Blair Hostetler<sup>2</sup>, Norman Pearson<sup>1</sup>

<sup>1</sup>Department of Earth and Planetary Sciences, Macquarie University, NSW 2109, AUSTRALIA  
([pienmunj@minerals.nsw.gov.au](mailto:pienmunj@minerals.nsw.gov.au), [sijackson@laurel.ocs.mq.edu.au](mailto:sijackson@laurel.ocs.mq.edu.au),  
[norman.pearson@mq.edu.au](mailto:norman.pearson@mq.edu.au))

<sup>2</sup>Department of Chemistry, Macquarie University, NSW 2109, AUSTRALIA  
([blair.hostetler@mq.edu.au](mailto:blair.hostetler@mq.edu.au))

The stable isotope geochemistry of Sb is unknown due to the lack of suitable analytical techniques in the past. The recent development of multiple collector – inductively coupled plasma mass spectrometry (MC-ICP-MS), however, offers a high precision method for Sb isotope analysis. The MC-ICP-MS combines the benefits of the tremendous ionisation efficiency of an ICP source with the precise isotope ratio measurement capability of a double focussing mass spectrometer with multiple analogue detection.

To determine whether measurable natural variation in Sb isotopic ratios exists, a suite of antimony minerals from a wide variety of geological environments was acquired for analysis. The Sb sample from Finland was provided by the Geological Survey of Finland; the remaining samples were supplied by the Smithsonian Institute. The samples were digested using three methods: (1) aqua regia, (2) HCL + C<sub>4</sub>H<sub>6</sub>O<sub>6</sub> (tartaric acid), (3) HNO<sub>3</sub> + C<sub>4</sub>H<sub>6</sub>O<sub>6</sub>. Method 3 gave the best Sb recovery. Samples digested using this method were diluted to ca. 1 ppm and spiked with Sn to a concentration of ca. 1 ppm. The samples were analyzed using a Nu Plasma MC-ICP-MS (Nu Instruments) in static mode. Sn was used to calculate a mass bias correction for Sb, as it was found that this technique produces higher external precision than standard bracketing, when repeatedly measuring an in-house Sb standard (1 ppm solution prepared from Baker Instruments' 1000 ppm Sb in 10 % HCL). The results were calculated as epsilon  $\epsilon^{123}\text{Sb}$  units where  $\epsilon^{123}\text{Sb}$  is a measure of the  $^{123}\text{Sb}/^{121}\text{Sb}$  ratio relative to the in-house Sb standard, in parts per 10,000.

Results of these measurements (Table 1 & Figure 1) show: (1) Sb isotope ratios for the in-house standard were measured with an external precision (2 $\sigma$ ) of ca. 2  $\epsilon$  units, and (2)  $\epsilon^{123}\text{Sb}$  values for the mineral samples showed a range, -9.5 to 4.9  $\epsilon$  units, much larger than the precision of the method.

Table 1:  $\epsilon^{123}\text{Sb}$  values

Sample	Age	Genesis	Mineral	$\epsilon^{123}\text{Sb}$
Seinäajoki, Finland,	Proterozoic	Magmatic	Sb	- 6.1
Arecheybo, Mexico	?	?	Sb	- 3.5
Engineer Mine B.C. Canada,	Tertiary	Epithermal	SbAs	- 9.5
Union Mine, Colorado U.S.	Tertiary	Epithermal	Sb <sub>2</sub> S <sub>3</sub>	- 5.9
Lake George Mine, New Brunswick, Canada	Devonian	Epithermal	Sb <sub>2</sub> S <sub>3</sub>	- 5.5
Jerritt Canyon, Nevada, U.S.	Tertiary	Epithermal	As <sub>2</sub> S <sub>3</sub>	+ 4.9

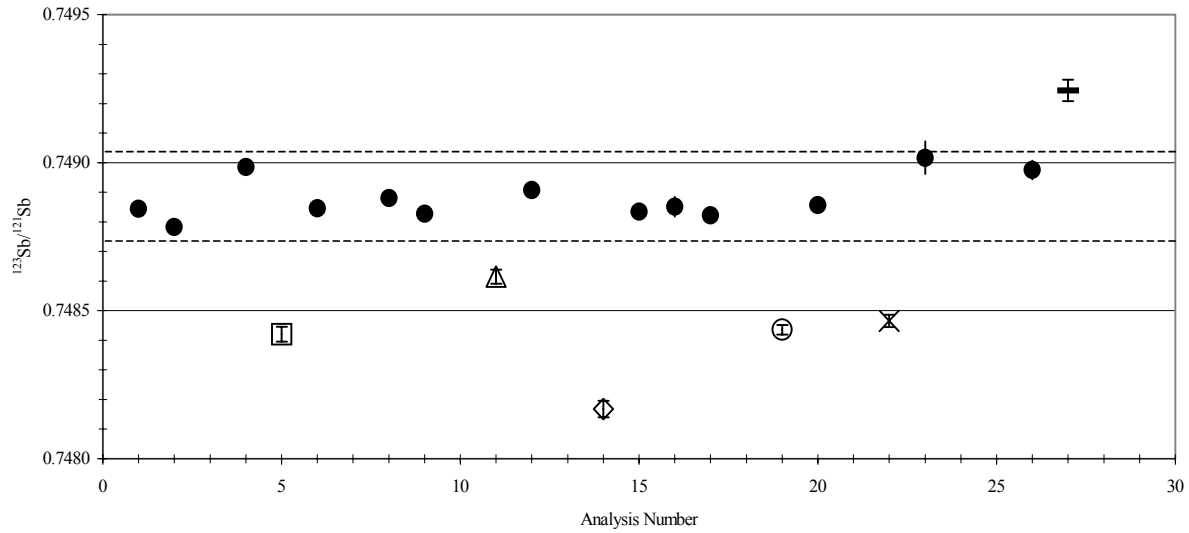


Figure 1:  $^{123}\text{Sb}/^{121}\text{Sb}$  Vs Analysis Number (Dashed lines = mean plus/minus 2 sd for in-house standard)

- In-house standard
- Sb Finland - Proterozoic, magmatic (?)
- △ Sb Mexico - (?)
- ◇ SbAs Canada - Tertiary, epithermal
- Sb2S3 Colorado - Tertiary, epithermal
- × Sb2S3 Canada - Devonian, epithermal
- As2S3 Nevada - Cretaceous, epithermal

Initial results suggest that temperature of mineralisation may be the cause of some of the observed variation in the isotopic compositions of the samples. Other possible factors are the isotopic composition of the source rocks and microbial reduction of Sb. A future aim of this study is to determine the fractionation effects of these factors. It is hoped that the knowledge gained can be applied to shed new light on the source and transport of Sb and other metals in the Sb-bearing Co-Ag-Ni-As ore deposits of the Cobalt – Gowganda area Northern Ontario.